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DESCRIPTION

5 IMPACT ABSORBING TYPE STEERING COLUMN APPARATUS FOR
AUTOMOTIVE VEHICLE

Technical Field

The present invention relates to an impact
absorbing type steering column apparatus for an
10 automotive vehicle.

Background Arts

In a steering column apparatus for an automotive
vehicle, according to a telescopic type capable of
adjusting a steering column in axial directions,
15 corresponding to a driving position (posture) of a
driver, for example, an upper column is fitted in a
telescopically slidable manner to a lower column
fixed to a car body.

Further, according to a non-telescopic type
20 incapable of making the telescopic adjustment, for
instance, the upper column is so fitted to the lower
column fixed to the car body as not to slide at a
normal time.

Moreover, an electric power steering type in a
25 column assist system is that an electric power assist
apparatus is provided at a column portion between a
steering wheel and an upper joint of an intermediate

shaft, thus performing the steering assist.

By the way, when a secondary collision happens, the upper column is moved for collapsing along the lower column fixed to the car body towards the front side of the automotive vehicle, and in the meantime a variety of impact absorbing means absorb impact energy.

A fitting length between the two columns upon collapsing has, however, become comparatively short over the recent years.

As a result, upon the secondary collision, just when the upper column gets collapsed and is to start moving towards the front side of the automotive vehicle, the upper column might not necessarily smoothly slide on the lower column.

Especially in the electric power steering type in the column assist system, it is difficult to ensure a space for collapsing due to a spatial influence of a motor, a deceleration mechanism, etc., and hence the above tendency is conspicuous. Further, in the case of the electric power steering type in the column assist system and in the telescopic adjustment system, the tendency described above become more conspicuous.

Further, a fitting angle of a steering wheel (which is an angle of a steering shaft to the horizon) is set as large as 30 degrees or thereabouts,

depending on the automotive vehicles. In this case,
an acting direction of an impact load towards the
front side of the automotive vehicle is not
coincident with a slide direction of the upper column
5 at the fitting portions of the two columns, and
consequently blocking (unsmoothed) force acts on
between the fitting portions of the two columns. In
this case also, the upper column might not
necessarily smoothly slide on the lower column.

10 Such being the case, if the fitting length
between the two columns is comparatively short, or
even if the fitting angle of the steering wheel is
large, there is demand for a smooth start of the
movement of the upper column towards the front side
15 of the automotive vehicle.

Moreover, when performing a telescopic operation,
the operation involves effecting a movement in the
axial direction with one hand in a blocked state,
wherein operating force rises and a locked state
20 occurs as the case may be.

Note that for attaining a smooth start of the
movement of the upper column when collapsing, for
example, a spacer formed of a resin is interposed
between the two columns according to Japanese Utility
25 Model Application Laid-Open No. 1-172965, a spacer
formed of super high polymeric polyethylene is press-
fitted in between the two columns according to

Japanese Patent Application Laid-Open No. 9-95245,
and a spacer partially formed with a recessed portion
and including a metal mesh coated with Teflon
(registered trademark), is press-fitted in between
5 the two columns according to Japanese Patent No.
2983130.

Disclosure of the Invention

It is an object of the present invention, which
10 was devised under such circumstances, to provide an
impact absorbing type steering column apparatus for
an automotive vehicle that is capable of a smooth
start of a movement of an upper column towards a
front side of the automotive vehicle even if a
15 fitting length between a lower column and the upper
column when collapsing upon a secondary collision is
comparatively short, and so on.

To accomplish the above object, in an impact
absorbing type steering column apparatus for an
20 automotive vehicle in which an upper column is fitted
to a lower column fixed to a car body so as to absorb
an impact energy upon a secondary collision while
moving the upper column along the lower column
towards a front side of the automotive vehicle, there
25 is provided an improvement characterized in that a
low-friction material treatment is effected on one or
both of slide surfaces of fitting portions of the two

columns.

Thus, according to the present invention, the low-friction material treatment is effected on one or both of the slide surfaces of the fitting portions of the two columns, and hence a slide load of the upper column can be reduced by decreasing a coefficient of friction on the slide surfaces of the fitting portions of the two columns. Accordingly, if a fitting length between the two columns is comparatively short, or even if a fitting angle of a steering wheel is large, a smooth start of the movement of the upper column towards the front side of the automotive vehicle can be attained.

As a result, subsequent collapsing can be smoothly performed, thereby facilitating control of the absorption of the impact energy. Further, as a consequence of the smooth start of the movement of the upper column, none of a blocking load affects the two columns, thereby enabling the collapsing to be smoothly done.

Moreover, in the case of a telescopic adjustment system, handling is done with one hand in a blocked (unsmoothed) state when performing the operation for the telescopic adjustment, resulting possibly in a rise in operating force. According to the present invention, however, the low-friction material treatment is effected on one or both of the slide

surfaces of the fitting portions of the two columns,
and therefore the operating force for the telescopic
adjustment can be reduced by decreasing the
coefficient of friction on the slide surfaces of the
5 fitting portions of the two columns, whereby the
operation for the telescopic adjustment can be
smoothly conducted.

Note that a collapsing stroke implies a
collapsing length, and the collapsing implies the
10 absorption of the impact energy through plastic
deformation and the like.

Brief Description of the Drawings

FIG. 1 is a side view of an impact absorbing
15 type steering column apparatus in a tilt/telescopic
adjustment system in a first embodiment of the
present invention;

FIGS. 2A and 2B are enlarged sectional views
taken along the line A-A and the line B-B in FIG. 1
20 (or FIG. 8), respectively;

FIG. 3 is a side view of the steering column
apparatus shown in FIG. 1, illustrating a shortest
telescopic adjustment state;

FIG. 4 is a view showing a state of an end of
25 absorption of an impact caused when a secondary
collision happens;

FIG. 5 is a side view of an impact absorbing

type steering column apparatus in a tilt/telescopic adjustment system in a second embodiment of the present invention;

FIG. 6 is a sectional view taken along the line
5 B-B in FIG. 5 or FIG. 11;

FIGS. 7A - 7C show a third embodiment of the present invention; FIG. 7A is a semi-sectional view of a sleeve; FIG. 7B is a partial sectional view showing a modified example of an inner column; FIG.
10 7C is a partial sectional view of a further modified example of the inner column;

FIG. 8 is a side view of an impact absorption type steering column apparatus in the tilt/telescopic system according to a fourth embodiment of the
15 present invention;

FIG. 9 is a side view of the steering column apparatus shown in FIG. 8, showing a shortest telescopic adjustment state;

FIG. 10 is a side view of the steering column
20 apparatus shown in FIG. 8, showing a state in which the absorption of the impact generated upon the secondary collision is terminated;

FIG. 11 is a side view of an impact absorption type steering column apparatus in the tilt/telescopic
25 system according to a fifth embodiment of the present invention;

FIG. 12A is a side view of an impact absorption

type steering column apparatus in the tilt/telescopic system according to a sixth embodiment of the present invention; FIG. 12B is a sectional view taken along the line b-b in FIG. 12A;

5 FIG. 13A is a side view of an impact absorption type steering column apparatus in a non-telescopic adjustment system according to a seventh embodiment of the present invention; FIG. 13B is a rear view (showing the front side as viewed from the rear side
10 of the automotive vehicle) of the steering column apparatus shown in FIG. 13A;

 FIGS. 14A - 14C are semi-sectional views of the steering column according to an eighth embodiment of the present invention; FIG. 14A is the semi-sectional
15 view showing a first example thereof; FIG. 14B shows a semi-sectional view and a rear view illustrating a second example thereof; FIG. 14C is the semi-sectional view showing a third example thereof; and

 FIGS. 15A - 15D are semi-sectional views of the steering column according to the eighth embodiment of the present invention; FIG. 15A is the semi-sectional
20 view showing a fourth example thereof; FIG. 15B is a semi-sectional view showing a fifth example thereof; FIG. 15C is the semi-sectional view showing a sixth
25 example thereof; FIG. 15D is the semi-sectional view showing a seventh example thereof.

The Embodiments of the Invention

An impact absorbing type steering column apparatus of a tilt/telescopic adjustment type according to embodiments of the present invention, will hereinafter be described with reference to the drawings.

(First Embodiment)

FIG. 1 is a side view of the impact absorbing type steering column apparatus of the tilt/telescopic adjustment type in a first embodiment of the present invention.

FIGS. 2A and 2B are sectional views taken along the line A-A in FIG. 1 and the line B-B in FIG. 1, respectively.

FIG. 3 is a side view of the steering column apparatus shown in FIG. 1, illustrating a shortest position in a telescopic adjustment.

FIG. 4 is a view showing a state of an end of absorption of an impact caused when a secondary collision happens.

As shown in FIGS. 1, 2A and 2B, the first embodiment illustrates an example of a fastening lock mechanism of a center holding type tilt/telescopic adjustment apparatus. An inner column 1 is fitted in a telescopically slidable manner into an outer column 2. A steering shaft 3 is rotatably supported within the two columns 1 and 2.

The outer column 2 is secured to a car body through proper fastening members (unillustrated) by horizontally extending members 104 of a car body sided bracket 4 of the fastening lock mechanism of the tilt/telescopic adjustment apparatus. As shown in FIG. 2A, the car body sided bracket 4 integrally has a pair of side plate members 4a and 4b respectively formed with tilt adjustment grooves 5a, 5b and extending in a perpendicular direction with the outer column 2 interposed therebetween.

A ring-shaped member 6 is provided along an outer periphery of the outer column 2. The ring-shaped member 6 is constructed of a member 6a taking substantially in a U-shape and a bolt 6b for fastening both of lower side ends of this member 6a.

The outer column 2 is provided integrally with a pair of flanges 7a, 7b anterior and posterior to the ring-shaped member 6. The flanges 7a, 7b are held between the two side plate members 4a, 4b of the car body sided bracket 4.

A lower end of the outer column 2 is formed with a slit 2a extending in an axial direction between the flanges 7a and 7b. When one pair of flanges 7a, 7b are pinched and held by the two side plate members 4a, 4b, the slit 2a is closed, whereby the outer column 2 shrinks in its diameter. This contrivance enables fastening in a tilt/telescopic adjustment position in

such a way that the outer column 2 presses the inner column 1.

A bolt 8a is provided outwardly of one side plate member 4a of the car body sided bracket 4, and
5 a front end of the bolt 8a is fixed to the ring-shaped member 6.

The bolt 8a is provided with a manipulation lever 9 and a cam lock mechanism. The cam lock mechanism is structured of a first cam member 10
10 rotating integrally with the manipulation lever 9 and a second cam member 11 that is non-rotational. The first cam member 10 moves in the axial direction while a crest portion of the first cam member 10 engages with a target cam portion of the second cam
15 member 11 as the first cam member 10 rotates, thus locking therewith and unlocking therefrom. The non-rotational second cam member 11 and the bolt 8a are constructed integrally in terms of their rotational action. Namely, the bolt 8a is non-rotational. A
20 thrust bearing 12 is provided between a head of the bolt 8a and the manipulation lever 9.

A bolt 8b is provided outwardly of the other side plate member 4b of the car body sided bracket 4. An intermediate portion of the bolt 8b is thread-
25 engaged with the ring-shaped member 6, and a front end thereof penetrates through the outer column 2 and engages with a telescopic adjustment groove 13 formed

in the inner column 1. In the thus-constructed fastening lock mechanism of the tilt/telescopic adjustment apparatus, when fastened in the tilt/telescopic adjustment position, the manipulation
5 lever 9 is rotated in one direction. Thereupon, the cam/lock mechanism acts to separate the first cam member 10 and the second cam member 11 from each other, whereby the first cam member 10 presses the bolt 8a outwards (towards the left in FIGS. 2A and
10 2B), and the second cam member 11 presses one side plate member 4a of the car sided bracket 4 inwards (towards the right in FIGS. 2A and 2B).

The bolt 8a pressed outwards (towards the left in FIGS. 2A and 2B) pulls inwards the bolt 8b on the
15 opposite side through the ring-shaped member 6, whereby the bolt 8b presses the other side plate member 4b of the car body sided bracket 4 inwards (towards the left in FIGS. 2A and 2B).

Thus, one pair of side plate members 4a, 4b of
20 the car body sided bracket 4 are respectively pressed inwards, as a result of this, one pair of flanges 7a, 7b are pinched and held by the side plate members 4a, 4b, and the slit 2a of the outer column 2 is closed, whereby the outer column 2 shrinks in its diameter.
25 With this diametrical shrinkage, the outer column 2 presses the inner column 1, thereby enabling the fastening in the tilt/telescopic adjustment position.

In this way, the two columns 1, 2 are fastened evenly from both sides, and hence the center of the two columns 1, 2 can be invariably kept.

When released from the tilt/telescopic
5 adjustment position, the manipulation lever 9 is rotated in the other direction, the cam/lock mechanism acts to make the first cam member 10 and the second cam member 11 approach each other, whereby the first cam member 10 moves the bolts 8a inwards
10 (towards the right in FIGS. 2A and 2B), and the second cam member 11 releases the pressing upon one side plate member 4a of the car body sided bracket 4, and opens one side plate member 4a outwards (towards the left in FIGS. 2A and 2B).

15 As a result of the inward movement (towards the right in FIGS. 2A and 2B) of the bolt 8a, the bolt 8b on the opposite side can be released through the ring-shaped member 6 from being pulled inwards (towards the left in FIG. 2). The other side plate
20 member 4b of the car body sided bracket 4 is thereby opened outwards (towards the right in FIGS. 2A and 2B).

Thus, the pair of side plate members 4a, 4b of car body sided bracket 4 respectively expand outwards,
25 with the result that the pair of flanges 7a, 7b expand outwards, whereby the inner column 1 can be released from being fastened by the outer column 2.

Next, in the first embodiment, as shown in FIG. 1, a low-friction material treatment is effected over at least a lengthwise range of the telescopic adjustment on one or both of the slide surfaces of the fitting portions of the two columns 1, 2. The low-friction material treatment is one of baking of molybdenum disulfide, baking of fluororesin, baking of a mixture of molybdenum disulfide and fluororesin, coating of a ceramic, a metal soap treatment, a low-friction plating treatment and coating of a lubricating agent such as grease, etc. but is not limited to these treatments.

Further, the telescopic adjustment groove 13 is, as illustrated in FIGS. 2A and 2B, a bottomed groove extending in the axial directions. The telescopic adjustment groove 13 is formed so that a groove width thereof becomes gradually smaller as its position gets closer to an end portion from a central portion thereof. With this contrivance, in a section indicated by [EA], the front end of the bolt 8b sequentially expands the telescopic adjustment groove 13, whereby the impact energy can be absorbed. Note that the telescopic adjustment groove 13 may also be a through-hole. The outer column 2 may be formed with a telescopic adjustment groove similar to the groove 13, with which the front end of the bolt 8a engages, wherein both of the bolts 8a and 8b may

absorb the impact energy.

Supposing that, for example, when in a state (a telescopic neutral position) shown in FIG. 1, a secondary collision is to happen, a load equal to or larger than sustainable force is applied upon the fastening lock mechanism in a tilt/telescopic adjustment position, the inner column 1 moves along the outer column 2 fixed to the car body towards the front side of the automotive vehicle, while the front end of the bolt 8b engages with the telescopic adjustment groove 13.

When the inner column 1 moves towards the front side of the automotive vehicle and reaches a position (a shortest telescopic adjustment position) shown in FIG. 3, the front end of the bolt 8b enters the section (EA) where the groove width of the telescopic adjustment groove 13 gradually decreases.

Thereafter, as seen in an illustrative transition from FIG. 3 to FIG. 4, the inner column 1 further moves towards the front side of the automotive vehicle. On this occasion, the front end of the bolt 8b sequentially expands the telescopic adjustment groove 13, thereby generating a collapse load. The impact energy is thus absorbed. As shown in FIG. 4, when the inner column 1 moves down to the end of the telescopic adjustment groove 13, the collapsing finishes.

Thus, according to the first embodiment, the low-friction material treatment is effected on one or both of the slide surfaces of the fitting portions of the two columns 1, 2, and hence the slide load of the inner column 1 can be reduced by decreasing a
5 coefficient of the friction on the slide surfaces of the fitting portions of the two columns 1, 2. Accordingly, if a fitting length between the two columns 1, 2 is comparatively short, or even if a
10 fitting angle of the steering wheel is large, a smooth start of the movement of the inner column 1 towards the front side of the automotive vehicle can be attained. The low-friction material treatment may be executed also on the slide-abutting surface shown
15 by [EA] for absorbing the impact energy.

As a result, the subsequent collapsing can be smoothly performed, thereby facilitating the control of the absorption of the impact energy. Further, as a consequence of the smooth start of the movement of
20 the inner column 1, none of a blocking load affects the two columns, thereby enabling the collapsing to be smoothly done.

Moreover, in the case of the telescopic adjustment system, if handled with one hand when
25 performing the operation for the telescopic adjustment, the movement of the inner column through within the outer column gets unsmoothed (blocked),

resulting possibly in a rise in the operating force for the telescopic adjustment. According to the first embodiment, the low-friction material treatment is effected on one or both of the slide surfaces of the fitting portions of the two columns 1, 2, and therefore the operating force for the telescopic adjustment can be reduced by decreasing the coefficient of friction on the slide surfaces of the fitting portions of the two columns 1, 2, whereby the operation for the telescopic adjustment can be smoothly conducted.

(Second Embodiment)

FIG. 5 is a side view of an impact absorbing type steering column apparatus of a tilt/telescopic adjustment type in accordance with a second embodiment of the present invention. In the second embodiment, an outer jacket 102 integral with the outer column 2, which will be explained later on, is integral with a gearbox of an electric power assist (Electric Power Steering (EPS)).

FIG. 6 is a sectional view taken along the line B-B in FIG. 5.

The second embodiment includes a column assist type electric power steering (EPS) apparatus, and is an exemplification of a tilt/telescopic fastening lock mechanism of such a type that a fastening bolt directly penetrates the outer jacket. The car body

sided bracket 4 whose horizontal portions 104 are fixed to the car body is integrally formed with a pair of side plate members 4a, 4b extending in the perpendicular directions with the outer column 2 interposed therebetween. A pair of embracing members 30a, 30b having large wall thickness and serving to embrace the inner column 1 and thus fasten the column 1, are integrally formed at a rear end of the outer column 2 between the side plate members 4a, 4b.

Lower ends of the pair of embracing members 30a, 30b respectively have flat portions swollen sideways suitably for being pressed by the side plate members 4a, 4b, and a slit 30c is formed in the middle between the embracing members 30a, 30b.

A stopper bolt 31 is fitted in an upper portion of the pair of embracing members 30a, 30b. A lower end of the stopper bolt 31 engages with the telescopic adjustment groove 13 of the inner column 1.

A fastening bolt 32 is inserted through the lower swollen portions of the pair of embracing members 30a, 30b between the pair of side plates 4a, 4b of the car body sided bracket 4. An adjustment nut 33 is screwed to a front thread portion of the fastening bolt 32, and the manipulation lever 9 is fitted through a fitting bolt 34 to the adjustment nut 33.

When fastened in the tilt/telescopic adjustment

position, upon turning the manipulation lever 9, the fastening bolt 32 moves to the left in FIG. 6, thereby pressing the pair of side plate members 4a, 4b of the car body sided bracket 4 inwards

5 respectively. As a result, the pair of embracing members 30a, 30b are, at their lower swollen portions, compressed narrow to close the slit 30c therebetween, whereby the inner column 1 can be fastened by pressing.

10 When in a tilt/telescopic cancellation, upon turning the manipulation lever 9 in the reversed direction, the fastening bolt 32 moves to the right in FIG. 6, thereby separating the pair of side plate members 4a, 4b from each other and the pair of
15 embracing members 30a, 30b from each other. With this separation, the pressing against the inner column 1 can be cancelled. The low-friction material treatment may also be effected on the slide-abutting surface for the energy absorption (EA).

20 Next, according to the second embodiment, as shown in FIG. 5, the low-friction material treatment is effected over at least the lengthwise range of the telescopic adjustment on one or both of the slide surfaces of the fitting portions of the two columns 1,
25 2. The low-friction material treatment is one of the baking of molybdenum disulfide, the baking of fluororesin, the baking of the mixture of molybdenum

disulfide and fluororesin, the coating of a ceramic,
the metal soap treatment, the low-friction plating
treatment and the coating of the lubricating agent
such as grease, etc. but is not limited to these
5 treatments.

Further, the telescopic adjustment groove 13 is,
as illustrated in FIG. 6, a groove extending in the
axial direction. The telescopic adjustment groove 13
is formed so that a groove width thereof becomes
10 gradually smaller as its position gets closer to an
end portion from a central portion thereof in the
axial direction. With this contrivance, a lower end
of a stopper bolt 31 sequentially expands the
telescopic adjustment groove 13, whereby the impact
15 energy can be absorbed. Note that the telescopic
adjustment groove 13 may also be a bottomed groove.

Moreover, there may be provided a plurality of
telescopic adjustment grooves 13 and a plurality of
stopper bolts 31 in a peripheral direction, and their
20 positions are shifted in the axial directions,
whereby an occurrence of a peak load may be prevented.

Assuming that, for instance, when in a state
(the telescopic neutral position) shown in FIG. 5,
the secondary collision is to happen, the load equal
25 to or larger than the sustainable force is applied
upon the fastening lock mechanism in the
tilt/telescopic adjustment position, the inner column

1 moves along the outer column 2 fixed to the car body towards the front side of the automotive vehicle, while the lower end of the stopper bolt 31 engages with the telescopic adjustment groove 13.

5 When the inner column 1 moves towards the front side of the automotive vehicle and reaches the shortest telescopic adjustment position, the lower end of the stopper bolt 31 enters a portion where the groove width of the telescopic adjustment groove 13
10 is small.

 Thereafter, the inner column 1 further moves towards the front side of the automotive vehicle. On this occasion, the lower end of the stopper bolt 31 sequentially expands the telescopic adjustment groove
15 13, thereby generating a collapse load. The impact energy is thus absorbed. When the inner column 1 moves down to the end of the telescopic adjustment groove 13, the collapsing finishes.

 Thus, also in the second embodiment, the low-
20 friction material treatment is effected on one or both of the slide surfaces of the fitting portions of the two columns 1, 2, and hence the slide load of the inner column 1 can be reduced by decreasing the coefficient of the friction on the slide surfaces of
25 the fitting portions of the two columns 1, 2. Accordingly, if the fitting length between the two columns 1, 2 is comparatively short, or even if the

fitting angle of the steering wheel is large, the smooth start of the movement of the inner column 1 towards the front side of the automotive vehicle can be attained.

5 As a result, the subsequent collapsing can be smoothly performed, thereby facilitating the control of the absorption of the impact energy. Further, as a consequence of the smooth start of the movement of the inner column 1, none of the blocking load affects
10 the two columns, thereby enabling the collapsing to be smoothly done.

 Moreover, in the case of the telescopic adjustment system, if handled with one hand when performing the operation for the telescopic
15 adjustment, the movement of the inner column through within the outer column gets unsmoothed (blocked), resulting possibly in the rise in the telescopic operating force. According to the second embodiment, the low-friction material treatment is effected on
20 one or both of the slide surfaces of the fitting portions of the two columns 1, 2, and therefore the operating force for the telescopic adjustment can be reduced by decreasing the coefficient of friction on the slide surfaces of the fitting portions of the two
25 columns 1, 2, whereby the operation for the telescopic adjustment can be smoothly conducted.

 In the second embodiment illustrated in FIG. 5,

the embracing members 30a, 30b integral with the outer column 2 is made integral with the EPS gear box but may also be separated therefrom.

(Third Embodiment)

5 FIGS. 7A - 7C show a third embodiment. FIG. 7A is a semi-sectional view of a sleeve. FIG. 7B is a partial sectional view showing a modified example of the inner column. FIG. 7C is a partial sectional view of a further modified example of the inner
10 column. Each of these sleeves is inserted in between the outer column 2 and the inner column 1 of the steering column apparatus as shown in, e.g., FIG. 5.

 In the example in FIG. 7A, a sleeve 14, of which an inner surface is subjected to the low-friction
15 material treatment, is fitted into portions corresponding to the fitting portions of the two columns along the inner surface of the outer column 2 of the steering column apparatus shown in FIG. 5. The low-friction material treatment is one of the
20 baking of molybdenum disulfide, the baking of fluororesin, the baking of the mixture of molybdenum disulfide and fluororesin, the coating of a ceramic, the metal soap treatment, the low-friction plating treatment and the coating of the lubricating agent
25 such as grease, etc. but is not limited to these treatments.

 Further, a single slit 14a is formed in a

circumferential area, thereby facilitating the low-friction material treatment on the inner surface. This is because rounding work can be carried out after the low-friction material treatment. Moreover,
5 the low-friction treatment may be effected also on the outer periphery of the inner column.

FIG. 7B shows an example in which a plurality of protruded streaks 15 are formed in the peripheral direction of the inner column 1. When collapsed, the
10 protruded streaks 15 on the inner column 1 are press-fitted into the outer column 2, thereby generating the collapse load. The impact energy is thus absorbed. The low-friction material is coated over at least one of the inner column and the outer column.
15 An area formed with the protruded streaks on the inner column 1 serves as the energy absorption (EA) range, while the left side area of the inner column 1 from the protruded streak 15 in FIG. 7B serves as the telescopic adjustment range.

FIG. 7C shows an example in which the inner column 1 is formed so that its diameter gradually becomes larger in the sequence of a small-diameter portion 16a, an intermediate-diameter portion 16b and a large-diameter portion 16c. When collapsed, the
20 small-diameter portion 16a, the intermediate-diameter portion 16b and the large-diameter portion 16c of the inner column 1 are sequentially press-fitted into the

outer column 2, thereby generating the collapse load. The impact energy is thus absorbed. The inner column 1 may be formed in an elliptical shape suited for changing its diameter. The low friction material is
5 coated over at least one of the inner column and the outer column.

As described above, according to the present invention, the impact absorption system may be the system for press-fitting into the outer column 2, or
10 may be the system for expanding the telescopic adjustment groove 13 as in the first and second embodiments, or may also be a combination of these systems. Other systems are available without being limited to those systems on condition that the energy
15 absorption types be those utilizing the relative movement of the inner column to the outer column.

(Fourth Embodiment)

FIG. 8 is a side view of an impact absorption type steering column apparatus of the tilt/telescopic type according to a fourth embodiment of the present
20 invention.

FIG. 2A is a sectional view taken along the line A-A in FIG. 8. In the fourth embodiment, the tilt/telescopic adjustment mechanism is the same as
25 that in the second embodiment.

FIG. 9 is a side view of the steering column apparatus shown in FIG. 8, showing a shortest

telescopic adjustment state.

FIG. 10 is a side view of the steering column apparatus shown in FIG. 8, showing a state in which the absorption of the impact generated upon the
5 secondary collision is terminated.

In the fourth embodiment, as illustrated in FIG. 8, a metallic ring 20 formed of iron, etc. is press-fitted or otherwise into a predetermined position of an outer peripheral surface of the inner column 1.
10 An annular damper 21 formed of a rubber or a synthetic resin is provided integrally with the metallic ring 20 on the side of the outer column 2.

As illustrated in FIG. 9, the metallic ring 20 and the damper 21, when adjusted to the shortest
15 telescopic adjustment state, act as a stopper for regulating the telescopic slide by abutting on the outer column 2. Moreover, on this occasion, the damper 21 prevents abutting noises caused by abutting on the outer column 2 and also restrains an impact
20 thereof.

Further, supposing that the secondary collision happens when in the state shown in FIG. 8, the load equal to or larger than the sustainable force is applied upon the fastening lock mechanism in the
25 tilt/telescopic adjustment position, the inner column 1 moves along the outer column 2 fixed to the car body towards the front side of the automotive vehicle,

while the front side end of the bolt 8b engages with the telescopic adjustment groove 13.

When the inner column 1 moves to some extent towards the front side of the automotive vehicle, the
5 metallic ring 20 and the damper 21 impinge on the rear end of the outer column 2. Thereafter, as shown in FIGS. 9 and 10, the inner column 1 further moves towards the front side of the automotive vehicle. On this occasion, the metallic ring 20 frictionally
10 slides on the outer peripheral surface of the inner column 1 moving towards the front side of the automotive vehicle while engaging with the rear end of the outer column 2, thereby generating the collapse load. The impact energy is thus absorbed.
15 As shown in FIG. 10, when the inner column 1 moves down to the end of the telescopic adjustment groove 13, the collapsing finishes.

From what has been discussed so far in the fourth embodiment, it is possible to extremely easily
20 to set and adjust the collapse load by adjusting the fitting state (the fastening state) of the metallic ring 20.

Moreover, according to the fourth embodiment, as shown in FIG. 8, the low-friction material treatment
25 is effected on one or both of the slide surfaces, especially at least on the collapse slide surface at the fitting portions of the two columns 1, 2. The

low-friction material treatment may also be effected on the slide-abutting surface in the energy absorption range. The low-friction material treatment is one of the baking of molybdenum disulfide, the baking of fluororesin, the baking of the mixture of molybdenum disulfide and fluororesin, the coating of a ceramic, the metal soap treatment, the low-friction plating treatment and the coating of the lubricating agent such as grease, etc. but is not limited to these treatments.

Thus, according to the fourth embodiment, the low-friction material treatment is effected on one or both of the slide surfaces of the fitting portions of the two columns 1, 2, and hence the slide load of the inner column 1 can be reduced by decreasing the coefficient of the friction on the slide surfaces of the fitting portions of the two columns 1, 2. Accordingly, if the fitting length between the two columns 1, 2 is comparatively short, or even if the fitting angle of the steering wheel is large, the smooth start of the movement of the inner column 1 towards the front side of the automotive vehicle can be attained.

As a result, the subsequent collapsing can be smoothly performed, thereby facilitating the control of the absorption of the impact energy. Further, as a consequence of the smooth start of the movement of

the inner column 1, none of the blocking load affects the two columns, thereby enabling the collapsing to be smoothly done.

Moreover, in the case of the telescopic
5 adjustment system, if handled with one hand when performing the operation for the telescopic adjustment, the movement of the inner column through within the outer column gets unsmoothed (blocked), resulting possibly in the rise in the telescopic
10 operating force. In the fourth embodiment, the low-friction material treatment is effected on one or both of the slide surfaces of the fitting portions of the two columns 1, 2, and therefore the operating force for the telescopic adjustment can be reduced by
15 decreasing the coefficient of friction on the slide surfaces of the fitting portions of the two columns 1, 2, whereby the operation for the telescopic adjustment can be smoothly conducted.

(Fifth Embodiment)

20 FIG. 11 is a side view of an impact absorption type steering column apparatus of the tilt/telescopic type according to a fifth embodiment of the present invention. In the fifth, the tilt/telescopic adjustment mechanism is the same as that in the
25 second embodiment.

FIG. 6 is a sectional view taken along the line B-B in FIG. 11.

In the fifth embodiment, as illustrated in FIG. 11, a metallic ring 20 formed of iron, etc. is press-fitted or otherwise into a predetermined position on the inner column 1. A damper 21 formed of a rubber
5 or a synthetic resin is provided integrally with the metallic ring 20 on the side of the outer column 2.

The metallic ring 20 and the damper 21, when adjusted to the shortest telescopic adjustment state, act as a stopper for regulating the telescopic slide
10 by abutting on the outer column 2. Moreover, on this occasion, the damper 21 prevents abutting noises caused by abutting on the outer column 2 and also restrains an impact thereof.

Further, if the secondary collision happens and
15 when the inner column 1 moves to some extent towards the front side of the automotive vehicle, the metallic ring 20 and the damper 21 impinge on the rear end of the outer column 2. Thereafter, the inner column 1 further moves towards the front side
20 of the automotive vehicle. On this occasion, the metallic ring 20 frictionally slides on the outer peripheral surface of the inner column 1 moving towards the front side of the automotive vehicle while being engaged and stopped with the rear end of
25 the outer column 2, thereby generating the collapse load. The impact energy is thus absorbed.

In the fifth embodiment, the outer jacket 102

integral with the outer column 2 is formed integrally with a housing of the electric power assist (Electric Power Steering (EPS)) mechanism.

From what has been discussed so far in the fifth embodiment, it is possible to extremely easily to set and adjust the collapse load by adjusting the fitting state (the fastening state) of the metallic ring 20.

Moreover, according to the fifth embodiment, as shown in FIG. 11, the low-friction material treatment is effected on one or both of the slide surfaces of the fitting portions of the two columns 1, 2. The low-friction material treatment is as described above and effected in at least the telescopic slide-abutting range anterior to the ring and may also be effected posterior to the ring.

Thus, according to the fifth embodiment, the low-friction material treatment is effected on one or both of the slide surfaces of the fitting portions of the two columns 1, 2, and hence the slide load of the inner column 1 can be reduced by decreasing the coefficient of the friction on the slide surfaces of the fitting portions of the two columns 1, 2. Accordingly, if the fitting length between the two columns 1, 2 is comparatively short, or even if the fitting angle of the steering wheel is large, the smooth start of the movement of the inner column 1 towards the front side of the automotive vehicle can

be attained. As a result, the subsequent collapsing can be smoothly performed, thereby facilitating the control of the absorption of the impact energy.

Moreover, in the case of the telescopic
5 adjustment system, if handled with one hand when performing the operation for the telescopic adjustment, the movement of the inner column through within the outer column gets unsmoothed (blocked), resulting possibly in the rise in the telescopic
10 operating force. In the fifth embodiment, the low-friction material treatment is effected on one or both of the slide surfaces of the fitting portions of the two columns 1, 2, and therefore the telescopic operating force can be reduced by decreasing the
15 coefficient of friction on the slide surfaces of the fitting portions of the two columns 1, 2, whereby the telescopic operation can be smoothly conducted.

(Sixth Embodiment)

FIG. 12A is a side view of an impact absorption
20 type steering column apparatus of the tilt/telescopic type according to a sixth embodiment of the present invention. FIG. 12B is a sectional view taken along the line b-b in FIG. 12A.

In the sixth embodiment, the metallic ring 20 is
25 fitted on an outer peripheral surface of an inner column 40 subjected to the low-friction material treatment described above. The metallic ring 20 is

constructed of a pair of half-ring segments 20a, 20b into which the ring 20 is segmented by half. The pair of half-ring segments 20a, 20b are fastened at their upper and lower ends by a pair of bolts 51, 52.
5 A damper 21 formed of a synthetic resin is covered over the pair of half-ring segments 20a, 20b.

Thus, a gap between the two pieces of half-ring segments 20a, 20b is changed by varying the fastening force of the pair of bolts 51, 52, whereby the
10 fitting state (fastening state) of the metallic ring 20 can be adjusted and the collapse load can be set and adjusted much easier than in the embodiments discussed above.

(Seventh Embodiment)

15 FIG. 13A is a side view of an impact absorption type steering column apparatus of a non-telescopic type according to a seventh embodiment of the present invention. FIG. 13B is a rear view (showing the front side as viewed from the rear side of the
20 automotive vehicle) of the steering column apparatus shown in FIG. 13A.

The impact absorption type steering column apparatus in the seventh embodiment comes under a non-telescopic adjustment system incapable of making
25 the telescopic adjustment, wherein an inner column 61 is so press-fitted into an outer column 62 formed integrally with a car body sided bracket 60 as not to

slide thereon at a normal time, and a steering shaft 63 is rotatably supported within the two columns 61, 62. If the secondary collision happens, however, a contrivance is that the inner column 61 becomes
5 movable along the outer column 62 towards the front side of the automotive vehicle.

Next, in the seventh embodiment, the metallic ring 20 formed of iron, etc. is press-fitted or otherwise into a predetermined position on the inner
10 column 61. The damper 21 formed of a rubber or a synthetic resin is provided on the metallic ring 20 on the side of an outer column 62.

If the secondary collision happens and when the inner column 61 moves to some extent towards the
15 front side of the automotive vehicle, the metallic ring 20 and the damper 21 impinge on the rear end of the outer column 62. Thereafter, the inner column 61 further moves towards the front side of the automotive vehicle. On this occasion, the metallic
20 ring 20 frictionally slides on the outer peripheral surface of the inner column 61 moving towards the front side of the automotive vehicle while engaging with the rear side end of the outer column 62, thereby generating the collapse load. The impact
25 energy is thus absorbed.

From what has been discussed so far in the seventh embodiment, it is possible to extremely

easily to set and adjust the collapse load by adjusting the fitting state (the fastening state) of the metallic ring 20.

Moreover, according to the seventh embodiment, as shown in FIGS. 13a and 13B, the low-friction material treatment is effected on one or both of the slide surfaces of the fitting portions of the two columns 61, 62. The low-friction material treatment is as described above. The low-friction material treatment is effected on the press-fitting portions of the two columns 61, 62 or on the energy absorbing portion.

In the seventh embodiment, the low-friction material treatment is effected on one or both of the slide surfaces of the fitting portions of the two columns 61, 62, and hence the slide load of the inner column 61 can be reduced by decreasing the coefficient of the friction on the slide surfaces of the fitting portions of the two columns 61, 62. Accordingly, if the fitting length between the two columns 61, 62 is comparatively short, or even if the fitting angle of the steering wheel is large, the smooth start of the movement of the inner column 61 towards the front side of the automotive vehicle can be attained. As a result, the subsequent collapsing can be smoothly performed, thereby facilitating the control of the absorption of the impact energy.

(Eight Embodiment)

FIGS. 14A - 14C are semi-sectional views of the steering column in an eighth embodiment of the present invention. FIG. 14A is the semi-sectional view showing a first example thereof. FIG. 14B shows a semi-sectional view and a rear view illustrating a second example thereof. FIG. 14C is the semi-sectional view showing a third example thereof. The eighth embodiment can be applied to the fourth through seventh embodiments discussed above.

FIGS. 15A - 15D are semi-sectional views of the steering column in the eighth embodiment of the present invention. FIG. 15A is the semi-sectional view showing a fourth example thereof. FIG. 15B is a semi-sectional view showing a fifth example thereof. FIG. 15C is the semi-sectional view showing a sixth example thereof. FIG. 15D is the semi-sectional view showing a seventh example thereof.

In FIGS. 14A - 14C and 15A - 15D, the right side corresponds to the rear side of the automotive vehicle, while the left side corresponds to the front side of the automotive vehicle. In the respective Figures, the configurations on the front and rear sides of the automotive vehicle are the same as the configurations of the front and rear sides of the ring 20 and of the damper 21 in FIG. 11. In the case of the eighth embodiment, when the collision happens,

the ring 20 impinges on the outer jacket,
subsequently the collapsing progresses to such an
extent that the outer jacket impinges on the ring 70,
thereby absorbing the energy.

5 In the first example in FIG. 14A, in addition to
the metallic ring 20 and the damper 21 that are
press-fitted as in the fourth embodiment, another
metallic ring 70 is provided in a different position
on the steering column 81 in the axial directions.

10 The second example in FIG. 14B is that the
steering column 81 is formed with four lines of
protruded streaks 82 spaced equally in the peripheral
direction. Each of the protruded streaks 82 extends
in the axial directions. The metallic ring 20 and
15 the damper 21 are press-fitted onto the outer
peripheral portions of these protruded streaks 82.
Note that the protruded streaks may be a plastically
deformable member as shown in the Figure and may also
be formed by cut-raising.

20 The third example in FIG. 14C is that the same
metallic ring 20 and damper 21 as those in the fourth
embodiment are fitted onto the portions of the
protruded streaks 82 on the front side of the
automotive vehicle. With this contrivance,
25 resistance caused by the frictional slide is
increased stepwise, thereby augmenting the collapse
load.

In the fourth example on FIG. 15A, the steering column 81 is constructed of a small-diameter portion 81a, an intermediate-diameter portion 81b and a large-diameter portion 81c. The same metallic ring 20 and damper 21 as those in the fourth embodiment are fitted onto the small-diameter portion 81a. Owing to this contrivance, the resistance caused by the frictional slide is increased at three stages, thereby further augmenting the collapse load. Moreover, the collapsing characteristic can be changed as intended in a way that properly changes lengths of the large-, intermediate- and small-diameter portions.

The fifth example in FIG. 15B is such that a tapered portion 81d is formed between the small-diameter portion 81a and the large-diameter portion 81c, and the metallic ring 20 and the damper 21 are fitted onto the small-diameter portion 81a. With this contrivance, the resistance caused by the frictional slide is gradually increased, thereby further augmenting the collapse load.

The sixth example in FIG. 15C is that the steering column 81 has the metallic ring 20 that is made thin in its wall thickness on the rear side of the automotive vehicle, and is formed with a resistance-escape hole 83. Owing to this contrivance, the resistance caused by the frictional slide is

reduced, thus attaining a scheme of decreasing the collapse load.

In the seventh example in FIG. 15D, the steering column 81 has the metallic ring 20 that is made thin in its wall thickness of a major-diametrical portion thereof on the rear side of the automotive vehicle. With this contrivance, the resistance caused by the frictional slide is reduced, thus attaining a scheme of decreasing the collapse load.

It is to be noted that the present invention can be modified in a variety of forms without being limited to the embodiments discussed above. The present invention can be applied to an electric power steering system and is highly effective in a column type electric power steering particularly because of difficulty of setting a sufficient amount of collapsing. Moreover, the present invention is also applicable to a tilt type and a telescopic type.

As explained above, according to the present invention, if the steering column apparatus is of the telescopic adjustment type, the low-friction material treatment is effected on one or both of the slide surfaces of the fitting portions of the telescopic adjustment portions between the two columns. Then, if the steering column apparatus is one of the non-telescopic adjustment type, the low-friction material treatment is effected on the press-fitting portions

of the two columns, and it is therefore possible to reduce the slide load of the upper column by reducing the coefficient of friction on the slide surfaces of the fitting portions of the two columns. Accordingly,
5 if the fitting length between the two columns is comparatively short, or even if the fitting angle of the steering wheel is large, the smooth start of the movement of the upper column towards the front side of the automotive vehicle can be attained.

10 As a result, the subsequent collapsing can be smoothly performed, thereby facilitating the control of the absorption of the impact energy. Further, as a consequence of the smooth start of the movement of the upper column, none of the blocking load affects
15 the two columns, thereby enabling the collapsing to be smoothly done.

Moreover, in the case of the telescopic adjustment type, if handled with one hand in the unsmoothed state when performing the telescopic
20 operation, resulting presumably in the rise in the operating force. According to the present invention, however, the low-friction material treatment is effected on one or both of the slide surfaces of the fitting portions of the two columns, and therefore
25 the telescopic operating force can be reduced by decreasing the coefficient of friction on the slide surfaces of the fitting portions of the two columns,

whereby the telescopic operation can be smoothly conducted.